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Indian Standard

SAFETY REQUIREMENTS FOR RADIO TRANSMITTING EQUIPMENT

(First Revision)

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

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Indian Standard

SAFETY REQUIREMENTS FOR RADIO TRANSMITTING EQUIPMENT

(First Revision)

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Indian Standard

SAFETY REQUIREMENTS FOR RADIO TRANSMITTING EQUIPMENT

(First Revision)

0. FOREWORD

0.1 This Indian Standard (First Revision) was adopted by the Indian Standards Institution on 24 November 1986, after the draft finalized by the Radio Communications Sectional Committee had been approved by the Electronics and Telecommunication Division Council.

0.2 The objects of this standard are to ensure:

a) the safety of skilled personnel when operating, carrying out routine adjustments to and, as far as practicable, during fault finding and repairing the equipment;

b) the safety of personnel, including unskilled personnel directed by skilled personnel, when the equipment is operating normally and also when operating under certain specific fault conditions which may arise in normal use;

c) the prevention of fire and its spread; and

d) the safety of personnel operating the equipment against harmful radiation.

0.3 This standard deals with protection against electric shock, skin burns, high temperature and fire, implosion and explosion, harmful radiation, and miscellaneous hazards. The requirements do not necessarily ensure the safety of unskilled personnel working on the equipment when it is not in normal operation.

0.4 Tests are specified, where appropriate, for checking that the equipment meets the safety requirements of this standard when operating normally and also under the specified fault conditions. The tests should be carried out on a representative set of equipment in order to determine whether the design meets the requirements of the Standard. The tests are neither mandatory nor limiting and may be modified by agreement between the manufacturer and the purchaser.

0.5 The use of this standard is not, however, intended to be restricted to type tests. It may also be used for acceptance tests after installation of the equipment, for tests after modifications to parts of the equipment, and for tests at appropriate intervals to ensure the continuing safety of the equipment throughout its life.

0.6 The text of Appendix B is based on the contents of IS : 6970-1973* which would be withdrawn with the publication of this standard.

0.7 This standard was originally based on IEC Pub 215 (1978) Safety requirements for radio transmitting equipment, issued by the International Electrotechnical Commission. It is now being revised so as to bring it in line with the latest edition of the IEC Publication.

0.8 This standard is largely based on IEC Doc : 12C (C. O.) 186 — Draft revision of Pub 215 : Safety requirements for radio transmitting equipment, issued by the International Electrotechnical Commission.

0.9 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960†. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard applies to radio transmitting equipment, including any auxiliary apparatus necessary for its normal operation as defined in IS : 10853 (Part 1)-1984‡ operating under the responsibility of skilled personnel. It applies to all radio transmitting equipment and ancillary apparatus, including combining units and matching networks. Only the antenna system and associated feeder lines are excluded.

1.1.1 This standard does not apply to transmitters of safety-insulated construction using double insulation or reinforced insulation and without provision for protecting earthing. This type of equipment is designated 'Class II Equipment' in IS : 9409-1980§ and is usually marked with the symbol shown in **D-2.2**.

*Code of practice for protection against possible hazards in radio transmitting equipment.

†Rules for rounding off numerical values (*revised*).

‡Methods of measurement for radio transmitters: Part 1 General conditions of measurements.

§Classification of electrical and electronic equipment with regard to protection against electric shock.

2. TERMINOLOGY

2.0 For the purpose of this standard the following definitions shall apply.

2.1 Skilled Personnel — Personnel are considered to be skilled if they have the necessary knowledge and practical experience of electrical and radio engineering to appreciate the various hazards that can arise from working on radio transmitters, and to take appropriate precaution to ensure the safety of personnel.

Guidance on assessing the competence of personnel for designation as skilled is given in Appendix A.

NOTE — The above definition and guidance in Appendix A detail the minimum requirements for a skilled person.

2.2 Electrically Safe — A part is electrically safe if it cannot cause a harmful electric shock or radio-frequency skin burn.

The conditions for a part to be electrically safe are:

either

a) the voltage between the part and earth, and also between the part and any other accessible part, does not exceed 72 V peak when measured with an instrument having an internal resistance of not less than 10 k ohms per volt;

or

b) the voltage exceeds 72 V peak, but the following limits with regard to *both* current and capacitance apply:

Current Limits

Frequency	*Current Limit*
dc	2 mA
less than 1 kHz	0·7 mA peak
1 kHz to 100 kHz	0·7 f mA peak
more than 100 kHz	70 mA peak

— where the current is measured in a non-inductive resistor of 2 k ohms connected between the part concerned and earth or any other accessible part; and f is the frequency in kilohertz.

Capacitance Limits

Voltage Range (U in volts peak)	*Capacitance Limit* (μF)
72 to 450	0·1
450 to 15 000	45/U
15 000	675 000/U^2

— where the capacitance limit is the capacitance between the part and earth, or any other accessible part, and the peak voltage, U, is measured in volts with an instrument having an internal resistance of not less than 10 k ohms per volt.

NOTE — Further information on the effects of current passing through the human body is given in **B-2**.

2.3 Creepage Distance in Air — Denotes the shortest distance, measured in air over the surface of the insulation, between two conductive parts.

2.4 Clearance — Denotes the shortest distance, measured in air, between two conductive parts.

2.5 By Hand — Denotes that the operation does not require the use of a tool, coin or any other object.

2.6 Accessible Part — A part is accessible Indian Standard if it can be touched by either of the standard test fingers described in 'Classification of degrees of protection provided by enclosures of electrical equipment' (*under preparation*) when applied in any direction with a force not exceeding 50 N.

In addition, to guard against flashover, any part carrying a voltage is regarded as accessible if its distance to the test finger is less than the clearances given in Appendix C.

2.7 Enclosure — Denotes a space in which items of equipment that might be dangerous are located and access to which is prevented except by routes specially provided, for example, a door or a removable cover plate.

2.8 Safety Device — Denotes any part or component provided for the purpose of protecting personnel from possible injury.

SECTION 1 GENERAL

3. INTRODUCTION

3.1 This section sets out the range of conditions of normal use and the fault conditions under which the equipment may operate without danger

to personnel, including unskilled personnel directed by skilled personnel. The equipment shall meet the safety requirements of this standard, when operating under the conditions of normal use given in **4** and also when any of the initial fault conditions detailed in **5** have been applied.

4. CONDITIONS OF NORMAL USE

a) The ambient atmospheric conditions for the equipment are within the following range:

temperature	:	+5°C to +55°C
relative humidity	:	45 percent to 75 percent
air pressure	:	86 kPa to 106 kPa (kN/m^2), (860 mbar to 1 060 mbar)

or within more stringent conditions agreed between the manufacturer and the purchaser.

b) The supply voltage and frequency is within the range for which the equipment has been designed.

c) For ac equipment, the waveform of the supply voltage is substantially sinusoidal (*see* **3.4.1.1** of IS : 10853 (Part 1)-1984* for definition of substantially sinusoidal).

d) For equipment which may be operated from ac or dc, either supply is applied separately.

e) The safety earth terminals or contacts, if any, are connected to earth (*see* **11.1**). Any other earth terminal shall also be connected to earth, unless the terminals are designed to be tightened by hand, in which case, they are left unconnected.

f) The access doors and cover plates or other protective covers, if any, are closed or fixed in position, unless they are designed to be opened or removed by hand; in which case they are left open or removed.

g) The equipment is operating in any position for which it has been designed to be used.

h) The equipment has its accessible controls at any setting.

j) The equipment is operating with any input signal condition given in the equipment specification.

*Methods of measurements for radio equipment transmitters: Part 1 General conditions of measurement.

5. FAULT CONDITIONS

5.1 Operating under fault conditions denotes that, with the equipment operating under the conditions of normal use given in **4**, one of the faults (a) to (h) is present, together with any associated consequential faults arising. The initial faults shall be applied separately, in turn, in any convenient order.

a) Short-circuits across creepage distances, if they are less than the values given in Appendix C, unless the insulation complies with the provision of **15**.

b) Short-circuits across clearances, if they are less than the values given in Appendix C.

c) Failure of any component considered to be potentially dangerous as determined from inspecting the equipment and studying the circuit diagram, unless the component is known to comply with relevant Indian Standards appropriate to the conditions of use in the equipment.

d) Connection of any unfavourable impedance to the radio frequency output connection, including open circuits and short-circuits.

e) Failure of any cooling system.

f) Continuous operation of motors, intended for intermittent operation, unless protection against this is included in the equipment.

g) Locking of moving parts in rotating or linear operating devices, if these can be jammed by mechanical failure.

h) The loss of a phase on a three-phase supply.

SECTION 2 COMPONENTS AND CONSTRUCTION

6. INTRODUCTION

6.1 The purpose of this section is to ensure that the equipment is designed and constructed to ensure safety of the personnel throughout the life of the equipment. Where no test method is given, compliance shall be checked by visual inspection and where appropriate by a functional test.

7. COMPONENTS

7.1 General Requirements — Components shall not be loaded in excess of their ratings under normal conditions nor, as far as practicable, under fault conditions. Normal and fault conditions are detailed in **4** and **5**.

The components may be tested either in the equipment or externally under conditions equivalent to those applying in the transmitter. The

number of components to be tested shall be agreed between the manufacturer and the purchaser.

7.2 Connectors

a) Connectors shall be designed so that they cannot be mated in a manner which might cause a hazard, for example, a connector for a circuit other than a supply circuit shall not be able to accept a mains supply connector. Mains supply connectors shall not be used for any other purpose, for example, for low-voltage supplies or signal circuits.

b) Connectors shall be constructed so as to prevent a bare wire inserted into the connector from penetrating the connector and making contact with any other part.

c) Connectors and internal connections for ancillary purposes such as monitoring shall have clearance and creepage distances to other circuits at least twice those specified in Appendix C.

d) Connectors with a non-detachable cord or cable shall comply with the requirements of IS : 616-1986*.

7.3 Switches — Circuit-breakers and manually-operated switches for the mains supply and other supply circuits shall have adequate making and breaking capacity under conditions of normal use. Circuit-breakers shall also have adequate making and breaking capacity under fault conditions.

Switches, including circuit-breakers and safety isolators, shall disconnect the equipment simultaneously from all poles of the supply source necessary to make the equipment safe.

An indication of the on and off position of such switches shall be provided and be clearly visible.

7.4 Fuse Links — Fuse links shall have an enclosed fuse element. The rating of the fuse link shall be marked on the fixed part of the assembly.

7.5 Parts Subject to Corrosion — The equipment shall be constructed so that there is no danger to personnel resulting from the failure of any part due to corrosion.

Tests shall be agreed between the manufacturer and the purchaser, and shall be performed after the equipment has been subjected to the appropriate corrosion test given in IS : 9000 (Part 11)-1983†.

*Safety requirements for mains operated electronic and related apparatus for household and similar general use (*second revision*).

†Basic environmental testing procedures for electronic and electrical items: Part 11 Salt mist test.

8. CONSTRUCTION

8.1 General Requirements

a) The equipment shall, as far as practicable, be constructed of non-flammable materials and shall have adequate strength to ensure safety.

b) Where the slackness of electrical connections could constitute a hazard, their tightness shall not be dependent upon the degree of compression applied to an insulating material. Screws which serve both as electrical and mechanical connections shall be adequately locked.

c) Moving parts liable to cause personal injury shall be adequately guarded.

d) Where parts can be set in motion by remote control, suitable precautions shall be incorporated to prevent possible injury.

e) Equipment shall be mechanically designed to minimize the possibility of injury to personnel, for example, from sharp edges, protruding corners, hot pipes, the release of potential energy from, for example, a spring, etc. Warnings shall be displayed where appropriate.

f) Attention shall be paid in the design of equipment to minimize the generation of acoustic noise, as exposure to excessive noise can cause damage to hearing and to the nervous system.

Where noise exceeds the safe value recommended in IS : 7194-1973*, notices shall be displayed giving the safe exposure time allowed and recommending that ear protectors should be worn. Such noise levels may, for example, exist in rooms housing cooling plant for large transmitters.

8.2 Resistance to Humidity — Test to check resistance to humidity shall be agreed between the manufacturer and the purchaser, and shall be made after the equipment has been subjected to the appropriate damp heat test given in IS : 9000 (Part 4)-1979†.

8.3 Resistance to Ingress of Water — If the transmitter is specified as protected against the ingress of water (*see* symbols in **D-3.1** to **D-3.4**), it shall remain safe when tested under the conditions agreed between the manufacturer and the purchaser. The tests shall be made after the

*Assessment of noise-exposure during work for hearing conversation purposes.

†Basic environmental testing procedures for electronics and electrical items: Part 4 Damp heat (steady state).

equipment has been subjected to the appropriate sealing test given in IS : 9000 (Part 15)-1982*.

8.4 Housing of Batteries — The arrangements for housing batteries shall provide adequate ventillation to remove gas and vapours, and ensure that leakage of noxious electrolyte will neither cause damage to other parts nor endanger personnel.

9. MARKINGS RELEVANT TO SAFETY

a) Markings shall be indelible and remain easily legible and discernible throughout the life of the equipment. Compliance is checked by visual inspection and by the following tests:

1) It shall not be possible to remove the marking by rubbing lightly in turn with two pieces of cloth, one soaked with water, the other with petroleum spirit.

2) When exposed to sunlight, the marking shall not fade so as to become illegible.

b) Markings shall, as far as practicable, be in the language appropriate to the area in which the equipment is to be used. The use of symbols, in accordance with Appendix D, is recommended to avoid language problems.

c) Switches and isolators specifically provided to render equipment safe shall be clearly marked as such to prevent ambiguity between these switches and other switches. The marking shall be in accordance with item (b) above.

d) Parts which serve as protection against harmful radiation, and which are intended to be removed during servicing, shall be marked with an appropriate warning.

SECTION 3 PROTECTION AGAINST HARMFUL ELECTRICAL SHOCK AND RADIO-FREQUENCY SKIN BURNS

10. INTRODUCTION

10.1 This section sets out the design principles that must be followed for transmitters in which dangerous voltages are present.

Where no test method is given, compliance shall be checked by visual inspection and, where appropriate, by a functional test.

*Basic environmental testing procedures for electronics and electrical items: Part 15 Sealing test.

11. EARTHING

11.1 Safety Earth Terminal — Accessible conductive parts shall be reliably connected to a safety earth.

In addition, the following provisions shall apply:

a) *Equipment to be Connected to Fixed Wiring* — A separate safety earth terminal shall be used. The terminal shall preferably be adjacent to the mains terminals, and shall be marked with the symbol in **D-2.1**.

The material of the earth terminal shall be electrolytically compatible with a copper earth conductor.

It shall not be possible to loosen the earth connection by hand.

b) *Equipment Provided with a Non-detachable Flexible Cord or Cable* — The requirements of item (a) above shall apply.

In addition, the cord or cable used for connecting the equipment to the mains supply shall include an insulated earth conductor of adequate cross-section, green in colour. This conductor shall be connected to the safety earth terminal of the equipment and, if a plug is provided, to the safety earth contact of the plug.

c) *Equipment Provided with a Mains Supply Connector* — The mains supply connector shall incorporate a safety earth contact which shall be an integral part of the connector.

The safety earth shall make contact before the supply when inserting the connector, it shall break after the supply is broken when removing it.

Safety earth terminals and safety earth contacts shall not be used for any other purpose.

11.2 Safety Earth Connections

a) Reliance shall not be placed on the conductibility of the cabinet framework for safety earth connections. Separate conductors routed to provide a suitably low impedance shall be used so that accessible parts are electrically safe both under normal conditions of use and under fault conditions.

b) Safety earth conductors shall not be used for any other purpose.

12. ENCLOSURES

12.1 The requirements for safety devices preventing access to enclosures

whilst dangerous voltages are present are given in **12.2** (*see* **2.7** and **2.8** for definitions of enclosure and safety devices).

Permissible voltages remaining on the equipment after the enclosures have been opened are given in **12.2**. Some additional safety provisions are described in **12.3**.

12.2 Safety Devices Relating to Enclosures

a) It shall not be possible to open access doors, or to remove cover plates or other protective covers which are designed to be removed by hand, before all dangerous voltages have been removed and accessible parts have been made electrically safe.

   In addition, it is recommended that all parts subject to peak voltages in excess of 1 000 V with respect to earth shall be earthed by means of a safety earthing switch before such opening or removal is possible.

b) The safeguarding shall be accomplished by safety devices forming part of the equipment. The design of the safety system shall be such that the safety of personnel is not dependent solely upon the satisfactory operation of relays, contactors, circuit-breakers, etc, which are electrically operated or employ hydraulic or pneumatic arrangements. For additional mechanical considerations concerning safety devices, refer to **13**.

c) The coupling between the safety mechanism and the locking of the means of access shall be effected in such a way that it will not be possible to gain access to an enclosure without the safety devices having operated correctly. To achieve this, a mechanical system is normally necessary.

d) The reapplication of dangerous voltages shall not be possible until the earth connection established by the safety earthing switch, if any, has been disconnected, and any cover plates have been replaced and access doors closed.

e) The safety system for equipment with access doors for enclosures shall include an arrangement to enable any person entering the enclosure to prevent the doors being closed and dangerous voltages being reapplied while he is inside.

12.3 Voltages Remaining on the Equipment

a) Parts becoming accessible after access doors have been opened, or cover plates or other protective covers designed to be removed by hand have been removed, shall be electrically safe in accordance with **2.2**.

b) In addition to the voltages which are allowed under **2.2**(a), it is permitted to have voltages on the equipment which do not comply with the requirements of **2.2**(b) provided that these voltages are not accessible and are less than 354 V peak with respect to earth, as measured with an instrument having an internal resistance of not less than 10 k ohm per volt.

Access shall be prevented by means of separate protective covers which cannot be removed by hand. These covers shall carry an appropriate warning in accordance with **9**(b).

12.4 Additional Provisions

a) As far as feasible, earthing wands shall be provided as an additional safety measure.

Such wands shall consist of an insulated handle, appropriate for the voltage encountered in the equipment, with a rigid conducting hook at one end. A flexible conductor of adequate cross-sectional area shall connect the conducting hook visibly to earth. If insulation is used on the conductor, it shall be transparent and loosely fitted over the conductor. Insulating beads may be used instead.

b) The design of the equipment shall be such that it is impossible to receive an electric shock by touching insulating material surfaces on the exterior, such as windows for viewing instruments, etc, or escutcheons, decorative features, etc, which are not earthed

Compliance is checked by a voltage test in accordance with **2.2**.

13. MECHANICAL CONSIDERATIONS CONCERNING SAFETY DEVICES

13.1 General Considerations

a) Safety devices shall be designed in accordance with the 'fail-safe' principle. They shall remain in or go to a condition which provides protection to personnel in the event of a fault within the device.

b) There shall be no possibility of a false indication of safety.

c) The operation of safety devices shall be such that transition from the 'safe' position to the 'unsafe' position cannot be carried out without deliberate action, nor shall there be ambiguity between the 'safe' position and the 'unsafe' position.

d) It shall not be possible to disable a safety device by hand.

e) Safety devices shall be designed to withstand such mishandling as may be expected in practice and continue to remain effective throughout the life of the equipment.

f) Safety earthing switches shall be constructed and mounted that the closing of the contacts is directly visible from a safe location.

g) Handles, knobs, etc, forming part of the safety system shall be reliably fixed to their shafts.

Mechanical drives shall be such as to prevent the possibility of slip or incorrect registration. This shall be ensured by positive means, such as keys, fully-secured pins, etc.

h) All parts of the safety system, including mechanical couplings, bearings, taper pins, etc, shall be reasonably accessible for inspection and maintenance.

14. WIRING

a) All conductors and cables shall be adequately protected against any risk of mechanical damage to which they may be liable in normal conditions of service;

b) Conductors within the equipment which are intended for monitoring, keying, control or modulating purposes, and which are connected to external circuits shall be protected from possible contact with other conductors within the equipment by adequate insulation, and preferably by physical separation, or by the use of an earthed screen; and

c) The terminating arrangement for flexible cables shall ensure that the electrical connections are free from mechanical strain and that the cables are protected from abrasion.

15. INSULATION

a) Where creepage distances are smaller than those specified in Appendix C, the insulating material shall be non-tracking and non-flammable.

For materials other than ceramic, the comparative tracking index shall be determined by the test method given in IS : 2834-1975*. The insulating material will be considered to be non-tracking if the comparative tracking index is equal to or greater than 175.

*Method for determining comparative tracking index of solid insulating materials under moist conditions (*first revision*).

Flammability shall be checked by the appropriate test given in IS : 11000 (Part 2)-1984*; and

b) Smaller creepage distances are allowed inside thermionic values, on tube bases and sockets, relays, plugs and sockets, printed circuit boards, transistors, micro-modules and similar devices, provided that they comply with their own specification.

16. VOLTAGES AT THE RADIO FREQUENCY OUTPUT CONNECTION

a) Transmitter radio frequency output connections which are not electrically safe, especially those for open wire feeders, are permitted if personnel cannot unintentionally approach a position where danger might exist. Guards or screens shall be provided, where necessary.

b) As far as feasible, the radio frequency output connection shall be arranged to drain off to earth any charges due to, for example, the accumulation of static charges which may give rise to dangerous voltages.

Attention is drawn to the fact that high voltages may exist at the transmitter output terminals due to coupling from other transmitters operating on the same site, and in such cases means shall be provided for making the parts affected electrically safe.

SECTION 4 HIGH TEMPERATURES, FIRE AND MISCELLANEOUS HAZARDS

17. INTRODUCTION

17.1 The purpose of this section is to ensure that personnel are not liable to injury from parts becoming excessively hot during normal operation and also that high temperature conditions do not arise which could cause fire or other hazards. This section also covers a number of additional hazards and the equipment shall be designed to avoid them.

When no test method is given, compliance shall be checked by visual inspection and, where appropriate, by a functional test.

18. HIGH TEMPERATURES

18.1 Permissible Temperature Rise Under Conditions of Normal Use — No accessible part of the equipment shall attain temperatures which might

*Fire hazard testing: Part 2 Test methods.

cause injury to personnel and no part shall attain temperatures which might cause deterioration of electrical insulation or impairment of mechanical strength.

IS : 616-1986* provides details of maximum values of safe temperature rise under conditions of normal use.

Other factors such as operator comfort and the need to provide reasonable working conditions may, however, often dictate a lower allowable temperature rise.

18.2 Temperature Rise Under Fault Conditions — Under the specified fault conditions (*see* **5**) no part of the equipment shall reach a temperature giving rise to danger of fire or the release of flammable or toxic gases.

Compliance with this requirement shall be checked by the following test:

If the temperature rise is limited by the operation of a thermal trip, overload trip or fuse, the temperature shall be measured 2 minutes after the operation of the device.

If no such device is fitted, the temperatures shall be measured until maximum temperature is attained, but for not longer than six hours operation of the equipment.

The temperatures shall be compared with the maximum safe working temperatures for the components and materials used. The maximum values of temperature rise under fault conditions indicated in IS : 616-1986* may be used as a guide.

19. FIRE

19.1 Equipment shall be so constructed that the possibility of fire and its spread is minimized.

The use of flammable components and materials, for example, non-fire-retardent plastics, should be avoided wherever reasonably practicable [*see also* **15**(a) and **18.2**].

Where it is not possible to avoid the use of components containing flammable fluids, measures shall be taken to contain any leakage of fluid and to prevent it coming into contact with components that might reach temperatures near to the ignition point of the fluid, or whose insulation may be damaged by it.

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*Safety requirements for mains operated electronic and related apparatus for household and similar general use (*second revision*).

20. IMPLOSION AND EXPLOSION

20.1 General Requirements — Components which are liable to implosion or explosion shall be so protected that personnel will not be exposed to danger.

20.2 Implosion — Cathode-ray tube or picture tubes of measuring or monitoring equipment with a maximum face dimension exceeding 16 cm shall either be intrinsically safe or the enclosure shall provide adequate protection against the effects of an implosion.

A non-intrinsically-safe tube shall be provided with a protective screen which cannot be removed by hand. If a separate screen of glass is used, it shall not be in contact with the surface of the tube. If the screen is removable, it must have a clearly visible warning in letters not less than 3 mm in height. The warning shall state that the screen must be in position before the equipment is made available for use.

Compliance shall be checked by visual inspection and, if necessary, by the tests described in IS : 616-1986* for intrinsically-safe tubes or for equipment having non-intrinsically-safe tubes.

20.3 Explosion

20.3.1 Components, which may cause danger by exploding, shall be equipped with a safety valve or have a clearly marked 'weak spot' in their structure to prevent the development of excessive pressures.

The safety valve or 'weak spot' shall be so situated that there will be no danger to personnel in the event of its operating.

21. HARMFUL RADIATION

21.1 Non-ionizing Radiation, Including Electromagnetic Fields — The transmitter shall be so constructed that there is no danger to personnel from any stray or cabinet non-ionizing radiation at radio frequencies. The electric or magnetic components of any stray electric and magnetic fields produced by the transmitting equipment shall not exceed 200 V/m or 0·5 A/m, respectively, over the frequency range 30 MHz to 30 GHz. These limits and the frequency range are provisional. The stipulated levels correspond approximately to a radiation power density of 100 W/m^2 (10 mW/cm^2) and apply to distances greater than 5 cm from accessible surfaces of the equipment.

NOTE — The limits given here relate to the performance of the equipment. In certain cases, lower limits and/or a maximum exposure time has to be observed for personnel in order to comply with the national exposure standards (*see* **B-8.1**).

*Safety requirements for mains operated electronic and related apparatus for household and similar general use (*second revision*).

Compliance shall be checked under normal operating conditions using antenna elements electrically short compared with the wavelength.

A standard method of measurement based on measurements of the electric and/or magnetic field components by small probes is under consideration.

21.2 Ionizing Radiation — The equipment shall be so constructed that there is no danger to personnel due to harmful ionizing radiation. Compliance shall be checked by measuring the amount of ionizing radiation near the outer surface of the enclosure. The value shall be less than 36 pA/kg (0·5 mR/h) measured under normal operating conditions at any readily accessible point 5 cm from the outer surface.

The method of measurement to be used shall be such that the appropriate spectrum of ionizing radiation is included.

21.3 General Requirements Concerning Radioactive Materials — A warning notice shall be affixed to equipment using tubes or any other items in which radioactive materials have been deliberately incorporated. Full instructions for the handling, storage and disposal of such devices shall be given in the equipment handbook, together with a note explaining the hazards associated with the materials.

NOTE — National regulations governing the use of radioactive material shall be observed.

22. DANGEROUS MATERIALS

22.1 Any dangerous materials incorporated in the equipment shall be listed in the equipment handbook which shall contain full instructions for the safe handling, storage and disposal of the materials, together with a note explaining the hazards associated with the materials contained in the components.

23. DANGEROUS SHORT-CIRCUITING OF LOW VOLTAGE SUPPLIES

23.1 Conductors and terminations in equipment containing high current/low voltage parts such as tube filament supplies and high-capacity batteries, although electrically safe as difined in **2.2** are liable to give rise to severe arcing or overheating if accidentally short-circuited, with the possibility of injury to personnel and the risk of fire.

Equipment containing such high current/low voltage parts shall be designed and constructed so as to minimize the possibility of dangerous short-circuiting.

APPENDIX A

(*Clause* 2.1)

GUIDANCE ON ASSESSING THE COMPETENCE OF PERSONNEL FOR DESIGNATION AS SKILLED

A-1. The definition of skilled in **2.1** is intended to ensure that personnel are considered to be skilled only if they are competent to take responsibility both for their own safety and for that of unskilled personnel under their immediate supervision, when working on the transmitter.

A-2. Competence in this context necessitates adequate technical knowledge, adequate practical experience and adequate detailed knowledge of the particular transmitter installation to avoid danger to personnel.

A-3. Training requirements for a skilled person should not be confined solely to technical matters and, desirably, should include first aid treatment, especially methods of artificial resuscitation; respiration and external cardiac compression (heart massage).

A-4. In practice it is not possible to give precise details of the technical knowledge, training and experience necessary for a skilled person because this depends on the type of transmitter and the duties concerned, which range from normal operation of a simple transmitter to the maintenance of a sophisticated transmitter containing high voltages as described in Appendix B.

APPENDIX B

(*Clauses* 2.2 *and* A-4)

GUIDANCE ON SAFETY PRECAUTIONS TO BE OBSERVED BY PERSONNEL WORKING ON TRANSMITTING EQUIPMENT

B-1. INTRODUCTION

B-1.1 To ensure the safety of personnel working on radio transmitters and associated equipment, a full appreciation of the various hazards involved is required.

The factors covered with respect to such work are:

— special precautions to be taken when using voltages exceeding 1 000 V peak;

— special precautions to be taken when using high radio-frequency voltages, often much higher than the voltages indicated above;

— the effects of electromagnetic fields existing in the vicinity of antennas leads which may introduce fire hazards, danger of electrical shock and burns to personnel;

— explosion hazards, where flammable gases are present;

— the risk, run by personnel working on structures or buildings, of falls which may be complicated by shock through accidental contact with live conductors.

B-2. DANGEROUS VOLTAGES AND CURRENTS

B-2.1 Fundamentally, current rather than voltage, is the criterion of shock intensity. The passage of even a very small current through a vital part of the human body can cause DEATH. The voltage necessary to produce the fatal current is dependent upon the resistance of the body, the contact conditions, the path through the body, etc.

Detailed information on the effect of electric shock is given in IS : 8437-1977*.

B-3. ELECTRIC SHOCK : FIRST-AID TREATMENT

B-3.1 Electric shock may result in interruption of natural breathing, immediate action is necessary to restore the breathing and it is, therefore, essential that personnel are familar with the various methods of respiration and heart massage.

In the case of high-voltage accidents, urgent medical aid is needed to test the effects of poisonous products in the body caused by severe burns.

In all cases, medical assistance shall be called.

It is necessary to check all personnel normally engaged in the operation and maintenance of transmitting equipment in which dangerous voltages may be present, for their ability to apply artificial resuscitation and to make arrangements for additional first aid training of such personnel, whenever needed.

*Guide on effects of current passing through the human body.

B-4. OPERATION OF TRANSMITTING EQUIPMENT

B-4.1 The equipment shall be kept constantly in such conditions as to comply with the relevant safety requirements.

B-4.2 At regular intervals, the condition of the equipment and the correct functioning of protective and safety device shall be checked by a skilled person approved by the appropriate authority for this duty.

Functional checks shall be carried out on interlocking systems of doors, mechanical interlocks, isolating switches, earthing switches, parallel resistances and protective devices against over-voltages and over-currents.

The above checks shall also be carried out after the protective and safety devices have operated under fault conditions.

The safety devices shall not be altered or disconnected except for replacement, nor shall the safety circuit be modified without specific approval of the appropriate authority in each case.

B-4.3 All covers giving protection against accidental contact with dangerous voltages, shall be kept closed under conditions of normal operation. They shall only be opened for maintenance or repair, when approved by the skilled person responsible.

B-4.4 All metal enclosures and covers of electrical and electronic equipment shall be effectively earthed, and care shall be taken to maintain these protective earth corrections.

B-4.5 The room occupied by equipment of open construction is to be considered as an enclosure, within the meaning of **2.7** of this standard.

B-4.6 When energizing a radio transmitter, the skilled person responsible shall satisfy himself that there is no-one at work on the equipment or its associated antenna system, that any work which may have been in progress is sufficiently completed to permit transmission, that no tools, testing equipment or handlamps are left in or on the equipment, and that all testing or ancillary apparatus connected for the purpose of testing has been removed.

B-5. PROCEDURE FOR ESTABLISHING THE ABSENCE OF VOLTAGE

B-5.1 Before starting work on the equipment, it shall be isolated from the mains supply. This disconnection shall always be checked by visual inspection. Further precaution shall be taken to ensure that the mains supply cannot be restored whilst work is being carried out.

After the mains supply has been disconnected, all other lines, such as control, interlocking and modulation lines shall, be disconnected if they carry dangerous voltages. Moreover, the antenna or the antenna transmission line shall be disconnected from the antenna terminal device to prevent the introduction of dangerous voltages due to antenna pick-up.

When disconnection of the antenna or antenna transmission line is not possible, other suitable precautions shall be taken, for example, earthing, when necessary at several places, to establish absence of voltage. These earthing connections shall be very short compared with the wavelength.

B-5.2 Capacitors which are connected to a circuit isolated from its supply shall be discharged and have their terminals permanently short-circuited and the casing earthed during the whole period of work.

B-5.3 The electrical charge retained by electrical machinery when stopped may, in certain cases, be sufficient to cause a severe shock. This shall be taken into account when making connections to an apparently 'dead' machine. Therefore all machinery shall be discharged and earthed using an adequately insulated lead for this purpose. The discharge operation shall be repeated several times.

B-5.4 Before any maintenance work is carried out on automatic or remote controlled equipment, the remote switching circuit shall be made inoperative.

B-6. PROCEDURE FOR DETERMINATION OF THE ABSENCE OF VOLTAGE

B-6.1 After the equipment has been isolated according to **B-5** the absence of voltage shall be determined at the working place. This may be done by the use of voltages indicators, measuring instruments, glow-discharge lamps for indicating radio-frequency voltages or other suitable means.

B-7. WORKING ON LIVE CIRCUITS

B-7.1 Whenever possible, work on live circuits with voltages over 350 V peak shall be avoided.

The visual inspection of live equipment, or parts of it should be permitted when the doors are opened, door interlockings bridged, protective covers removed or other protective measures made ineffective only by specific agreement of the appropriate authority and provided the inspection is carried out by a skilled person approved for this duty. In specific cases, especially in the presence of strong radio-frequency fields, suitable

measures shall be taken to indicate the areas of danger. Another skilled person shall be present to watch the working party, to switch off the epuipment in case of emergency.

B-8. OTHER HAZARDS

B-8.1 Radio-Frequency Radiation Hazards

a) The maximum levels of power density in the microwave range and/or the electric and magnetic components of field strength at lower radio-frequencies to which personnel may be exposed shall not exceed the prescribed limits.

NOTE — The limits given in **21.1** relate to the performance of the transmitting equipment, excluding the antenna system, over the frequency range 30 MHz to 30 GHz. Below 30 MHz higher limits may be appropriate.

b) Personnel shall never make a direct visual examination of any microwave radiator, reflector, waveguide, horn or day concentrated beam radiating system during periods of transmission.

APPENDIX C

[*Clauses* 2.6, 5.1(a), 7.2(c) *and* 15(a)]

CLEARANCES AND CREEPAGE DISTANCES

C-1. The clearances and creepage distances between parts shall be adequate to avoid failure under such conditions as a deposit of dust or moisture. The clearances and creepage distance in air, given in Table 1, are the minimum actual separation, taking into account tolerances in assemblies and piece-parts.

TABLE 1 CLEARANCE AND CREEPAGE DISTANCE

dc OR PEAK VOLTAGE (U) (V)	rms VOLTAGE ($U/\sqrt{2}$) (V)	CLEARANCE (mm)	CREEPAGE DISTANCE (mm)
Over 72 to 354	Over 50 to 250	3	3
Over 354 to 500	Over 250 to 360	3	4
Over 500 to 1 400	Over 360 to 1 000	$2 + \frac{U}{500}$	$2 + \frac{U}{250}$
Over 1 400	Over 1 000	Unless another criterion is agreed between the manufacturer and the purchaser, distances shall be such that no brush discharge can occur when the relevant parts are subjected to a voltage test with 2U V	

U = dc voltage or peak ac voltage (up to frequency of 1 000 Hz) under working conditions at nominal voltage +10 percent.

NOTE 1 — If an insulating part contains a groove and/or ridge of less than 1 mm width, the creepage distance is not measured over the surface of the groove and/or ridge, but only across its width.

NOTE 2 — If a clearance consists of two or more air gaps in series separated by conductive parts, any gap of less than 1 mm width is ignored in computing the total distance.

APPENDIX D

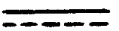
[(*Clauses* 1.1.1, 8.3, 8.4 *and* 9(b)])

SYMBOLS

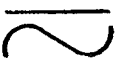
D-1. GENERAL SYMBOLS

D-1.1 AC Supply

D-1.2 DC Supply



D-1.3 AC and dc Supply



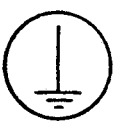
D-1.4 Three-phase ac Supply at Frequency *f*

D-1.5 Earth

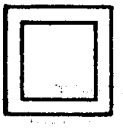
D-1.6 Aerial

D-2. SYMBOLS RELATING TO SAFETY

D-2.1 Safety Earth



D-2.2 Equipment of Safety Insulated Construction (Class II Equipment)



D-2.3 Dangerous Voltages

D-2.4 Ionizing Radiation Under consideration

D-3. DEGREE OF PROTECTION AGAINST MOISTURE

D-3.1 Drip Proof

(one drop)

D-3.2 Splash Proof

(one drop in a triangle)

D-3.3 Watertight

(two drops)

D-3.4 Immersion Proof

(two drops in a triangle)

(*Continued from page* 2)

Panel for Transmitters, LTDC 20/P6

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